

Getting the Big Picture of a Small Place

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ABSTRACT

Most commercial and industrial program evaluations do not have sufficient resources to conduct comprehensive market characterization studies. Generally the population is so large that it is impossible to allocate sufficient resources to capture information about all market participants. In 2000, the Vermont Department of Public Service, recognizing its resources were limited but so was their market, requested an evaluation that included a characterization of the Vermont commercial and industrial market as part of the evaluation of the Efficiency Vermont commercial and industrial sector programs.

The project that emerged from this request is quite possibly the most comprehensive market assessment of a commercial industrial market to date. Although focused on a very small place – the state of Vermont – it appears to provide valuable lessons for commercial industrial construction markets throughout the nation.

The project includes characterizations of architects, engineers, contractors, suppliers, and real estate developers and managers, as well as end-users in newly constructed and in existing buildings. On-site studies of a nested sample of end-users provide further data on market conditions. The findings reveal the process by which decisions are made to install energy efficient equipment and use energy efficiency solutions from the perspectives all market actors.

Introduction

In 2000, the Vermont Department of Public Service (“DPS”) requested a characterization of the Vermont commercial and industrial (“C&I”) building market as part of the evaluation of the Efficiency Vermont commercial and industrial sector programs. The resulting project includes characterizations of architects, engineers, contractors, suppliers, real estate developers and managers, and end-users in newly constructed and in existing buildings. On-site studies of a nested sample of end-users provide further data on market conditions. The findings reveal the process by which decisions are made to install energy efficient equipment and use energy efficiency solutions from the perspective all market actors.

Efficiency Vermont is the only utility in the nation whose sole purpose is to help users of electricity save energy through efficiency. Efficiency Vermont began operating in March 2000, offering programs including service to C&I firms (end users) initially built on prior utility sponsored programs. It’s programs focus on opportunities for energy efficiency in new construction, major renovations, remodeling, and equipment

replacements. Efficiency Vermont offers financial incentives and technical assistance to C&I firms and the building and equipment professionals they work with.

This paper presents our findings from the C&I building market characterization. The paper begins with a description of our approach. Next, it provides a sketch of Vermont—the “small place” delimiting the market. We present our findings as “close-up pictures” of the C&I market. We conclude with our view of the “big picture” of the operation of the C&I building market in Vermont.

Approach

During 2001-2002, we conducted telephone surveys among three broad types of market actors, contacting samples of numerous distinct groups within each broad category.

(1) We surveyed C&I firms—the end users in the building construction market. We surveyed about 100 firms that had constructed new facilities and 100 firms that had renovated, remodeled, or added on to existing facilities. (These samples comprised 20% and 29% of their respective populations.) Both sets of firms had received construction permits during 1998 or 1999. We surveyed a general sample of about 400 C&I firms (2% of the population), some of which had made building equipment purchases in the past two years, thereby participating in the construction market. We conducted 76 on-site surveys of interviewed C&I firms to provide more detailed data on market conditions.

(2) We surveyed market actors—the professionals and equipment suppliers that comprise the supply-side of the construction market. We surveyed samples of architects, engineers, general contractors, electrical contractors, and mechanical contractors. The samples ranged in size from 31 to 16 and comprised between 24% and 13% of their respective populations. We surveyed samples of suppliers of windows, lighting, HVAC, and motors, with sample sizes ranging from 7 to 4 (ranging from 18% and 3% of the respective populations). We intentionally oversampled large market actors in order to understand their influence in the market.

(3) We surveyed real estate professionals—developers and property managers (16 in total; 10% of the population). These professionals act as both suppliers to the market and end users of the services of the market actors.

The resulting 12 telephone survey instruments explored the construction market behaviors and energy efficiency activities appropriate to each sample group. For topics that were appropriate to multiple groups, the surveys approached the topics consistently across the groups. Thus, we were able to compare responses to these topics across all the groups for which the topic was explored.

We developed working papers on the findings from each sampled group. In the final report, we synthesized the findings across the groups to provide a characterization of the Vermont C&I building construction market (GDS Associates, 2003).

The Small Place

Vermont is a small and rural state, covering roughly 9,250 square miles and home to 608,827 residents. The average number of persons per square mile is 66, less than the

national average of 80 people per square mile, which includes large amounts of sparsely populated territory in Alaska and other Western states.

Approximately 20,000 C&I firms are located in Vermont. Overall, Vermont firms show the same variation in size as other New England firms. More than half of the state's C&I firms occupy buildings under 5,000 square feet in size, while fewer than 15 percent of them (or less than 3,000 firms) occupy buildings of 25,000 square feet or more. To put Vermont's C&I stock in perspective, another utility in the Northeast serving a more populated area that is about half the size of Vermont has nearly 4,000 large C&I accounts—two and one-half times more dense than Vermont.

During 1998-1999, the state issued 839 construction permits to C&I establishments. The firms undertaking construction were somewhat larger, on average, than general C&I firms: 41% of constructing firms were under 5,000 square feet and 19% were over 25,000 square feet, compared with 54% and 12% of general C&I firms. The distribution by size of the construction projects was comparable to the size distribution of the general C&I firms.

Among the general C&I population, about 40% had purchased equipment (windows, heating, and or lighting) in the two years prior to the survey. Of those that had purchased equipment, about 40% had purchased windows, 54% had purchased heating equipment, and 57% had purchased lighting. (Note that 12% had purchased all three systems and 28% had purchased two of the three systems.)

The designer and contractor populations are comprised primarily of firms with fewer than five people. Firms with four or fewer employees comprise 80% of the architectural firms, 46% of the engineering firms, 70% of general contractors, 75% of electrical contractors, and 65% of mechanical contractors.

Some Close-Up Pictures

The Clients Professionals Work With and the Professionals Clients Work With

Most of the designers and contractors work in both the new construction and renovation/remodeling markets and work for both C&I and residential customers. An exception to this was general contractors; the larger firms tended to work exclusively in the C&I sector. When describing the markets they work in, many respondents said, in essence, that they were fishing in a small pond and took whatever fish they could land in the boat.

Architects work on about half of all construction projects. Not surprisingly, the larger projects more likely involve architects than smaller ones, with the result that architects design about 60% of the floorspace. However, the skew toward the big projects is not as great as one might anticipate. While architects worked on two-thirds of the very largest projects, they nonetheless also worked on one-third of the smallest projects.

Mechanical and electrical engineers each work on about one-third of all construction projects. Engineers are much more likely to be involved in projects in excess of 25,000 square feet; thus, they work on about half of the total constructed floorspace.

Electrical contractors work on nearly every project—85% of projects and 89% of the total constructed floorspace. (Note that 4% of the construction projects did not install lighting.) General contractors are involved in almost as many projects—79% of projects

and 81% of floorspace. Mechanical contractors, like architects, have a moderate tendency to work on larger projects; they work on 68% of projects and 82% of floorspace (13% of projects did not install heating systems).

For half of the projects that did not use an architect, contractors worked directly with the project owners in a construction approach termed “design-build”. Fifty percent of contractors report at least half their work is design-build, and all but 25 percent report they do some design-build work. Ten percent of architects and 50 percent of engineers report doing a little design-build work.

Half of the projects involved one, two, or three types of professionals; 20% used four types, 15% used five types, and 13% used six types of professionals. Project size was not a factor in the number of professionals used except among projects involving six professionals. Half of all projects were under 5,000 square feet, yet only one-third of the projects using six professionals were that size.

We asked the C&I firms with construction projects and the construction professionals to identify the people that most influence the selection of heating equipment and the selection of lighting equipment. There was little agreement among the responses of the different groups, a finding that can be understood in light of the varying roles each group has in the construction market, which we discuss in the concluding section of this paper.

Engineers (electrical or mechanical) were reported by three groups (architects, engineers, and contractors—electrical or mechanical) as being among the top two decision-makers for equipment (lighting or HVAC). Building *owners* were reported by two groups (general contractors and equipment contractors—electrical or mechanical) as being among the top two decision-makers. Likewise, *mechanical contractors* were reported by two groups (themselves and building owners) as among the key decision-makers.

Owners also identified *general contractors* for HVAC decisions and *lighting contractors* for lighting decisions. Owners using engineers (each type of engineer works on about 30% of projects) typically named those professionals as most influential. *Suppliers* (lighting and HVAC) were mentioned by engineers as being among the top two decision-makers for equipment decisions. *Architects* (who work on 48% of projects) said they were among the key decision-makers for both lighting and HVAC equipment decisions, yet no other group identified them as such.

Discussion of Energy and Efficiency between Professionals and Clients

Just over half (55%) of the C&I firms with construction projects discussed energy use with one or more professionals. Sample-wide, firms were most likely to discuss energy use with general contractors (20% did so), but that finding is driven by the fact that most firms use general contractors. When one limits the investigation of each professional to only those firms using the professional, one finds that nearly half of the firms (45%) using electrical engineers discussed energy use with them. One-third of the firms using architects discussed energy use with the architect. About one-quarter of firms using general contractors discussed energy use with that professional, and the same proportion held for mechanical contractors and for mechanical engineers. Only one-fifth

of the firms using electrical contractors (and recall that 85% of all projects used one) discussed energy use with them.

We asked C&I firms whether any of the professionals they spoke with had encouraged energy efficiency, and whether any had discouraged it. Very few firms reported being discouraged from pursuing energy efficiency. Firms having conversations about energy with architects were most likely to have been encouraged to pursue energy efficiency (75% of these firms). Two-thirds of the conversations with mechanical engineers included an encouragement for energy efficiency, as did 62% of the conversations with general contractors, 55% of those with lighting contractors, 44% of those with electrical engineers, and 38% of those with mechanical contractors. For the sample as a whole (irrespective of the rates at which professionals were used or energy was discussed), 12% of firms with construction projects received encouragement for energy efficiency from architects and from general contractors, 9% received encouragement from lighting contractors, 7% from mechanical contractors, and 6% from mechanical engineers and from electrical engineers.

Twenty percent of firms with construction projects reported that they presented their construction professionals with requirements for energy use, such as to make the space more energy-efficient than it was previously or than is typical in similar buildings. About 90% of designers (architects and engineers) reported that their clients express a concern for facility energy costs. However, about two-thirds of designers believe their clients' concern exceeded their clients' willingness to address energy costs. We discuss this point further in the next section.

Barriers to Energy Efficiency Identified by Construction Professionals

Across all the groups of designers and contractors, a significant barrier is their difficulty in providing clients with reliable estimates of the benefits of energy efficiency. This barrier ranked within the top two most problematic barriers for three of the five market actor groups, as shown in Table 1.

Table 1. Percent of Market Actors Rating Barrier to Efficiency Options as Substantial

Barriers	Designers		Contractors		
	Architects (n=30)	Engineer (n=16)	General (n=31)	Mechanical (n=23)	Electrical (n=19)
Getting clients to authorize research expenses	63%	63%	NA	NA	NA
Getting reliable cost estimates for options	57%	19%	NA	NA	NA
Assessing performance of option in an application	40%	31%	NA	NA	NA
Getting reliable estimates of benefits*	37%	38%	32%	21%	26%
Identifying	20%	19%	NA	NA	NA

professional resources					
Getting clients to consider options	17%	13%	6%	26%	13%
Availability of efficient products	17%	31%	6%	21%	13%
Getting other professionals to consider efficient options	7%	31%	13%	37%	22%
Cost of options	NA	NA	35%	37%	22%

*For contractors, item is: "Getting accurate and objective information about options"

Architects and engineers rated the *ability to assess the performance of equipment in a specific application* and the *willingness of the client to authorize research into performance and benefits* as very substantial barriers to energy efficiency in construction projects. Only about 20 to 25% of designers are paid to conduct computer modeling and life cycle cost analyses in support of energy efficiency on at least half of their projects (see Table 2). These concerns are consistent with the finding on barriers found by some of the authors for architects in the Pacific Northwest (Peters & McRae, 2001). Size of design firm was not found to have a bearing on the barriers mentioned by these designers.

Table 2. Percent of Architects and Engineers Reporting Client Commitment to Energy Efficiency

Client Commitment to Energy Efficiency	Architects (n=30) At Least:		Engineers (n=16) At Least:	
	50% of Projects	Once in Past Year	50% of Projects	Once in Past Year
Client expressed concern for energy costs	87%	93%	81%	88%
Professional expressed more concern for facility energy costs than client expressed	63%	70%	63%	75%
Client willing to invest to have facility be more efficient than similar facilities in the state	53%	60%	31%	50%
Client paid for computer modeling of building or lighting system energy use	27%	33%	19%	50%
Computer modeling resulted in a more energy-efficient design being selected	23%	37%	6%	44%
Client paid for formal life cycle cost analysis of efficiency options	20%	37%	25%	31%

Contractors see the *cost of energy efficiency options* as a major barrier. Architects see as a major barrier the *ability to provide reliable estimate of the costs*, although most engineers do not share this concern.

Contractors see other contractors as major barriers to energy efficiency. Mechanical and electrical contractors point to general contractors as a barrier, while general contractors point to subcontractors as a barrier, though less of a barrier than the subcontractors see the general contractor. Engineers similarly see getting architects to consider options as a barrier; however, architects do not see engineers as a barrier. This “finger pointing” can be understood in light of the varying roles each group has in the construction market, which we discuss in the concluding section of this paper.

For equipment suppliers, barriers to increasing the market share of energy-efficient products are evident when the equipment features that are most important to customers are not included among the selling points suppliers emphasize for efficient equipment. Suppliers report customers consider availability, perceived quality/comfort, initial price and durability as important. Of these, only comfort and durability are also on the suppliers’ lists of selling features for energy efficient equipment. Not surprisingly, suppliers most frequently emphasize the energy savings of efficient equipment, yet the suppliers themselves do not think energy savings are among customers’ primary considerations window and motor purchases. And suppliers view energy savings as equal in importance, in the customer’s view, to other factors for lighting and HVAC purchases.

Were changes such as the following to occur, they would suggest that barriers to energy efficiency are being reduced: (1) Suppliers begin to tout features other than energy savings for the energy-efficient equipment they sell. (2) Architects and engineers are able to gain assistance and increased capability in assessing performance, benefits and costs. (3) Contractors find system benefits easier to estimate and find each other more willing to discuss and consider energy efficiency options.

Role of Client Awareness in Energy Efficiency and Factors Associated with Measure Installation

As one might expect, C&I firms with construction projects or equipment purchases had a higher awareness of the 13 efficiency measures we explored than did firms that had not undertaken construction or purchased any equipment. On an absolute basis, the awareness levels of firms with no equipment purchases trailed those with equipment purchases by about 10 percentage points. In relative terms, for every four firms with equipment purchases that were aware of a measure, only three firms without equipment purchases were aware (on average; there was some variation by measure). Those who had engaged in construction projects were more aware of efficiency measures than those with equipment purchases, although the differences were smaller than the previous comparison. For every ten firms engaged in construction that were aware of a measure, just under nine firms with equipment purchases were aware (on average).

Thus, there is some relationship between experience in the marketplace and awareness of efficiency measures. The most likely relationship is that C&I customers learn about efficiency measures in the process of constructing a building or purchasing equipment. The possibility remains that the awareness predated the marketplace experience. Possibly, the firms that are more aware are more likely to be thinking about their space and equipment needs and entering the construction market. This hypothesis suggests that firms with specialized staff—who think about equipment efficiencies and

needs—undertake construction more than firms without specialized staff. And it would follow that the firms with specialized staff are larger than those without.

We found no correlation between size of firm and awareness of efficiency measures among C&I firms that had made no equipment purchases. We found, however, that larger firms were more likely than smaller firms to have made equipment (windows, heating, and or lighting) purchases in the absence of a construction project. A (partial) correlation of number of measures the firm was aware of and firm size, controlling for whether the firm had purchased equipment, found no correlation between awareness and firm size.

Thus, we conclude that it is through the firms' marketplace interactions that they become aware of energy efficiency measures. For firms with equipment purchases but not construction projects, larger firms become more aware of efficiency measures than smaller firms. This finding did not hold for firms with construction projects. As already reported, firms with construction projects were somewhat larger than firms without construction projects. However, a regression analysis of awareness among firms with construction projects found that firm size and project size are *not* explanatory factors.

We sought to further understand the marketplace transactions by asking C&I firms with construction projects or equipment purchases whether they discussed using the efficiency measure with professionals and whether they installed the measures. Reported measure installation rates for firms with construction projects ranged from a high of 70% of the applicable population (those that had installed the equipment to which the measure applied) to a low of 18%. For firms with equipment purchases, installation rates ranged from 58% of the applicable population to 8%.

Both sets of firms reported installing measures that they had discussed with professionals about three-quarters of the time or more, depending on the measure. The rate of discussion of a measure taken as a proportion of those who were aware of the measure ranges from 82% to 31%, with the lower proportions associated with those measures having the lowest installation rates.

Two alternative hypotheses can account for these findings. The first hypothesis is that professionals discussed measures at considerably higher rates than the measures were ultimately installed, but that C&I firms tended to remember the discussions only when they went on to install the measures. The forgotten discussions resulted in the firms being aware of the measures, but they did not recall the source of their awareness nor report the discussion. This hypothesis leaves unexplained why some measures are installed at much higher rates than other measures, if indeed all measures are being discussed by professionals at roughly comparable rates.

The second hypothesis is that awareness of a measure does not, in itself, drive the extent to which a measure is discussed with a professional or installed. This hypothesis suggests that professionals are "gatekeepers" for energy efficiency. When they discuss efficiency measures with their clients, they are often influential and the measure is installed. This hypothesis leaves unexplained how firms become aware of efficiency measures, since the data already demonstrated that awareness results from interaction with the marketplace.

We conducted a multivariate regression analysis to determine the factors leading to the installation of efficiency measures. Our data did not enable us to pursue the roles of

awareness or discussion of measures in the regression, since firms reported installing only measures they were aware of and had discussed.

For firms with construction projects, we found the following. More efficiency measures were installed by larger firms (or alternatively, larger projects), by firms that had used the services of Efficiency Vermont, by firms using greater numbers of types of professionals, and by firms that discussed energy use with a mechanical engineer (or alternatively, discussed energy use with an architect or general contractor). (The alternative variables yielded equations of almost equal explanatory power.) Recall that number of types of professionals used is independent of firm size for all but the largest number: six professionals were more likely to be used by larger firms than smaller ones.

Firms with equipment purchases but not construction projects were not asked about the involvement of professionals, under the assumption that they had dealt primarily with suppliers. We later questioned this assumption, because the time frame for the construction projects and equipment purchases differed. It is likely that firms purchasing all three types of equipment were conducting construction projects. Nonetheless, we did not ask about the role of professionals. The regression equation showed that size of firm and use of Efficiency Vermont services were positively associated with measure installations.

The Big Picture

Social Networks

Social networks are the connections each of us have to others, including our patterns of communication and whom we receive resources from and give resources to. We may have different networks for our different spheres of activity: professional, community, familial, etc.

In large groups, we need a search strategy or filter to facilitate establishing effective networks. For example, among national or international companies, one often finds that the largest and most profitable firms deliver services to and seek services from other large, profitable firms.

Vermont is small both in terms of land size and population density. It is our opinion that the small size of the construction market in Vermont makes it possible and indeed, highly likely, that most commercial construction professionals in good standing are qualified to work on most commercial construction projects done in the state. It is the exceptional project that would require more expertise than is available from the typical, competent local professional. Vermont's building and construction designers, contractors, and suppliers seize the opportunities that present themselves: large or small projects, commercial or industrial or residential clients, nearby or farther away, new construction, renovation or remodeling.

In Vermont's C&I construction market, firms do not need to use a search strategy that stratifies service providers based on size or other predetermined characteristics. Word-of-mouth communication is particularly important. People tend to work with the people they know or are familiar with, and this familiarity promotes a feeling of trust prior to the establishment of the working relationship.

We do *not* find evidence that larger professional firms are more likely than smaller professional firms to have expertise in energy efficiency or to encourage its use. We do *not* see evidence in Vermont to support a theory that in large professional firms working with large customers are responsible for efficiency measure installation. Nor do we see small professional firms working primarily with small customers on small projects. In Vermont, one's social network can extend through most of the state. Consistent with this, we did not find a relationship between location within the state and the number of energy efficiency measures installed in permitted construction projects.

Engaging in the Construction Process Changes Clients

We have found firms undertaking construction or purchasing equipment are more aware than other firms of energy efficiency measures. We have found larger construction projects and larger firms are more likely than small and medium-size projects and firms to install energy efficiency measures. However, we have also found the interactions with professionals used on a project contributes on average at least as much as—and, in some cases, more than—firm size to the determination of the number of efficiency measures used. C&I firms installed more efficiency measures, on average, when they discussed energy use with mechanical engineers, or with architects or general contractors, than when such conversations did not take place. In addition, firms installed more measures when they had been in contact with more professionals, contact that increases the likelihood they are exposed to energy efficiency ideas. Finally, using statistical regression analysis, we found use of Efficiency Vermont services makes a positive contribution to the number of energy efficiency measures installed in projects.

Hypotheses about the Effects of Client and Project Size

We believe the following characteristics and conditions result in larger projects and firms installing more efficiency measures than smaller ones, although we are not able to test these hypotheses with our data: (1) Larger firms have more capital, and more access to capital, which enables them to cover higher initial costs of efficient equipment more easily than smaller firms can. (2) Larger firms have more staff and thus more staff time available to oversee and make decisions about project and equipment specifications than smaller firms have. (3) Larger firms have more staff and thus have more specialized staff; larger firms are more likely to have one or more staff members experienced in construction or knowledgeable about construction alternatives. (4) Larger projects have more opportunity to install efficiency measures as they include more varieties of lighting, HVAC equipment, and so on, and have a greater need for such measures as energy management systems.

So, Who Really Makes the Decisions about Efficiency?

Every market group was identified by at least one group as being among the top two decision-makers for HVAC and lighting equipment decisions. How do we understand this? Who is it that programs need to reach?

To answer this question, we need to consider the construction process.

In a traditional, architect-designed project, the owner hires an architect to produce design specifications (specs). The architect hires an engineer (as a consultant) to assist. When the specs are finished, the owner hires, through a bid process, a general contractor to construct a building according to the specs. The general contractor hires mechanical and electrical contractors (subcontractors) to assist in the construction. The general contractor purchases equipment from the supplier, and the owner can purchase directly from the supplier as well.

Design-build projects are more difficult to define since they occur in multiple ways. The owner does not usually hire an architect to generate the specs, although architects and, more frequently, engineers may be called in as consultants on the design. (In some places, there is a legal requirement for architect or engineer approval of the specs.) The owner hires a general contractor. The general contractor may hire the designers and subcontractors, or the owner may hire them directly. The owner may come to the process with a set of specs (such as when the owner has already constructed a similar facility—the source of the specs). Alternatively, the general contractor may already have a set of specs (perhaps from similar projects) or include in-house design capability sufficient to the task (such as needed for tilt-up construction or “big box” buildings). The general contractor and or the owner purchases from suppliers.

In equipment replacement projects, the owner usually directly hires the electrical or mechanical contractor. The contractor and or the owner purchases from suppliers.

Each of these scenarios is idealized. As we saw from the data on professionals involved in the projects, most construction projects used three or four of the six professionals we asked about (architects, mechanical engineers, electrical engineers, general contractors, mechanical contractors, electrical contractors).

There are three junctures in the process where key decisions are made that affect the building and equipment efficiency. (1) The extent to which the design itself minimizes building energy use; (2) the extent to which contractors modify the design in a way that increases energy use (often, to reduce first costs); and (3) the extent to which suppliers provide the most efficient equipment meeting the specs (or provide less efficient equipment, often to reduce first costs).

Thus, we see that all the market players—including the owner, who approves the specs, modifications to the specs, and the supplied equipment, either in a thoughtful or cursory way—have a direct effect on the efficiency of the building, and can act as a barrier to efficiency. In particular, those market players that influence the design *as it is implemented*—architects, mechanical engineers, and general contractors—have the greatest influence on efficiency. This conclusion is supported by our regression findings on the positive influence that discussing energy use with any of these three professionals has on total measures implemented.

Reducing Barriers to Energy Efficiency

Our research points to the need to increase the involvement of designers, contractors, and suppliers in energy efficiency. It is necessary to work with these professionals to increase their (1) motivation to pursue energy efficiency with clients, (2) knowledge of energy efficiency solutions (technologies, applications, benefits, costs), and

(3) ability to communicate with clients about energy efficiency in terms consistent with clients' objectives for their projects.

It is necessary to increase the communication among the construction professionals about energy efficiency. They would benefit from knowing firms in each discipline that pursue energy efficiency (to facilitate teaming), knowing how to talk to each other about efficiency (how to address each other's principle concerns), and understanding how energy efficiency can be integrated into each step of the construction process.

An "integrated design" approach represents the ideal level of communication among the professionals. In such an approach, the designers, contractors, and owners work together as a team to ensure that the building's design and equipment function together to minimize energy use in the building best meeting the owner's functional and aesthetic requirements. Among current practices, the design-build approach is more collaborative than traditional design and in this way offers a starting point for integrated design. However, design-build approaches are most often used in "no frills" construction and "value engineering", where cost-minimization equals or exceeds functional and aesthetic considerations.

It is necessary to recognize that although the construction objectives of traditional design more readily encompass energy efficiency than the objectives of design-build projects, the professional relationships in design-build projects more readily encompass the teaming necessary for energy-efficient integrated designs.

It is necessary to reduce the barriers of assessing the suitability of efficiency options for given applications and the costs and benefits of these applications. This can be accomplished by providing end-users or design professionals with financial incentives to cover analysis or by making accurate information readily available to design professionals interested in conducting such analyses.

It is necessary to include suppliers in program efforts to educate and motivate professionals. Engineers identified equipment suppliers as one of the two parties that most influence equipment decisions. Yet we found equipment suppliers to be among the least informed market actors in Vermont and the least willing to participate in our survey. This suggests suppliers are not being educated by the manufacturers and that designers, contractors and C&I firms are not demanding energy efficiency solutions from the suppliers.

Conclusion

Our study suggests energy efficiency efforts will have the greatest impact when they increase the ability of each of the market actors to talk about efficiency with clients and other professionals. Certainly, each market actor needs to know about available incentives and technical assistance options. Each market actor also needs an opportunity (from outreach, conferences, or training) to learn about efficiency options relating to their specific areas of expertise and how to discuss the options with other professionals and with clients. Efficiency Vermont's Better Buildings by Design Conference is expanding its sessions to cover topics specific to the different market actors' roles and needs. When efficiency programs only target owners, architects, and engineers, they are reaching only half (or less) of the barriers to efficient building construction.

References

GDS Associates, 2003. *Evaluation of the Commercial & Industrial Sector Markets and Activities of Vermont's Energy Efficiency Utility*. Prepared for the Vermont Department of Public Service, March 31, 2003. Montpelier, VT.

Peters, Jane S. and Marjorie McRae, 2001. *Third Market Progress Evaluation Report Architecture + Energy Program*. Prepared for the Northwest Energy Efficiency Alliance, June 30, 2001. Portland, OR.